TREMONT STATION BRIDGE
(N.Y.N.H.& H.R.R. Boston-Provincetown Bridge No. 45.38)
(Pierceville Road Bridge)
Pierceville Road, spanning Conrail Tracks
Wareham
Plymouth County
Massachusetts

HAER No. MA-141

HAER
MASS,
12-WARH,
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PHOTOGRPAHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
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Location: Pierceville Road, spanning Conrail tracks, Wareham, Plymouth County, Massachusetts

UTM Coordinates: 19.352450.4627440
U.S.G.S. Quadrangle: Snipatuit Pond, Mass.

Date of Construction: c1878; moved and re-erected at present location in 1887-88.

Builder: Keystone Bridge Company, Pittsburgh, Pennsylvania

Owner: Massachusetts Highway Department, 10 Park Plaza, Boston, MA 02116

Present Use: Vehicular bridge; partially dismantled and undergoing rehabilitation (9/95).

Significance: The Tremont Station Bridge is one of the oldest metal truss bridges in Massachusetts and the earliest to incorporate J.H. Linville's wide, upset-ended eyebars, a feature which would become standard in late nineteenth century pin-connected trusses. The bridge was built by an important nineteenth century bridge company, the Keystone Bridge Company. It is also of interest for its apparent original design as a railroad bridge and its later adaptation as a highway bridge.

Project Information: This documentation was initiated as an emergency mitigation measure during the Federally-funded rehabilitation of the Tremont Station Bridge by the Massachusetts Highway Department. During its dismantling for rehabilitation, the bridge was discovered to be far more seriously deteriorated than had been anticipated. This documentation has been prepared to mitigate the effect of the unexpectedly extensive repair work now required. This documentation was prepared between August 1995 and August 1996 by:

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Site Description

The Tremont Station Bridge[1] (now more commonly known as Pierceville Road Bridge) is located in the northwest comer of Wareham, Massachusetts in the village of West Wareham, historically known as Tremont. The bridge carries Pierceville Road over the tracks of the former Old Colony Railroad (later used by the New York, New Haven & Hartford Railroad; presently used by Conrail). The surrounding area is wooded and occupied primarily by mid-late twentieth century suburban tract houses, with a scattering of nineteenth century houses. The segment of Pierceville Road on which the bridge is located is less than one-quarter mile northwest of the former site of Tremont Station, and links Main Street on the north to Pierceville Road, Paper Mill Road and Route 58 on the south. The approaches to the bridge are steep and drop off sharply on either side, as they were built to eliminate a grade crossing at this site.

Bridge Description

The Tremont Station Bridge is a single-span structure comprised of a pair of pin-connected, wrought-iron Pratt pony trusses measuring 60'-0" long (center-to-center of bearing pins), 27'-0" wide (center-to-center of trusses) and 8'-0" high (center-to-center of upper and lower chord pins). Prior to being disassembled, the bridge rested on granite masonry, straight-wing abutments with stepped wingwalls. The clear span between the abutments is 53'-5" and the distance from the tracks to the floorbeams was 18'-4".

Each six-panel truss is comprised of a built-up upper chord and an eyebar lower chord, connected by vertical and diagonal members. The upper chord of each truss is comprised of two 10"x2 3/4" channels connected with a 16"x5/8" plate on the upper side and lacing and tie plates undemeath. The inclined endposts are built up in the same manner. The bottom of each inclined endpost is riveted to a 17 1/2"x27 3/4" plate with curved ends. These curved plates appear to have been designed as the upper plates of four roller bearing assemblies. Although Massachusetts Highway Department inspection reports mention roller bearings as late as 1994, no rollers or other bearing assembly elements could be located on site in September of 1995. The bottom chord is comprised of pairs of 6"x1 1/4" upset-ended eyebars in the outer panels and double pairs of 6"x1" upset-ended eyebars in the two center panels. The members are connected at each upper panel point with a 2 7/8" diameter pin fastened with a 4 7/8" diameter nut, except at the hip verticals which are connected with a 3 7/8" diameter pin fastened with a 6 1/8" diameter nut. The members are connected at each lower chord point, including the bearing points, with a 4 1/4" diameter pin fastened with a 6 1/2" diameter nut. All of the upset-ended eyebar heads gain 1/4" in thickness over the body of the bar and are thickest over

[1] This name has been inferred from the earliest documentation found in Old Colony Railroad records and town reports. Since the bridge was apparently moved at an early date, an official "historic" name for the structure could not be documented with absolute certainty. The bridge is located at the site historically referred to as Tremont Station, and has been located here since early in its history. The next earliest citation making reference to the bridge appears to be a 1926 record plan of the structure, entitled "N.Y.N.H. & H.R.R. Boston to Provincetown Bridge No. 45.38, Wareham Road." While this was the official designation of the bridge when it was under the railroad's purview, the bridge has been more commonly referred to by the station name or the modern (Pierceville Road) street name.

the pin. The upper and lower chords are connected by means of hip verticals (loop-welded eyebars) and vertical posts (paired channels laced back-to-back). Diagonals angling up toward the ends are comprised of paired upset-ended eyebars. Diagonal counters (square rods with turnbuckles and loop-welded eyes) pass between the pairs of diagonal eyebars in the two center panels.

The floor system as originally built consisted of built-up transverse floor beams, comprised of a web plate (22 1/4"x3/8"), top and bottom flange plates (12"x5/8") which are doubled over the central portion of each beam, and flange angles (3 1/2"x3 1/2"x3/8"). The floor beams were hung from the verticals by U-bolts which looped over the pin at each lower panel point. The U-bolts passed through the flanges of the floor beams, and were secured underneath with a 6"x1" plate and two nuts. The floor beams extended beyond the trusses to support outrigger sway braces, comprised of 3 1/2"x2 3/4" T-bars, which braced the upper chords of the trusses at each panel point. Timber stringers ran perpendicular to the floor beams and rested on shelf angles (originally 4"x3"x3/8") riveted to the webs of the floor beams. The floor beams were rebuilt in 1945, at which time the lower lateral system (1" diameter rods) was removed to make room for new shelf angles (6"x4"x1/2") which were riveted to the webs of the floor beams.[2] The floor beams still have anchor brackets for the lower lateral rods. In 1974 the stringers and timber plank deck were replaced with new 8"x12" stringers, 2"x6" timbers and 2" thick bituminous concrete pavement.

There is a founder's mark: "*Union Iron Mill, Pittsburgh, PA*," on the upper chord, and a small iron plaque bearing what appears to be the number "7" on the southeast endpost. A town water main also spans the tracks between the abutments, and is presently supported on a steel beam. When the bridge was in place, the water main rested between the lower chord and the sway braces on the east truss, and was supported on the outer ends of the extended portions of the floor beams.

Local History

Early in Wareham's history, a number of iron foundries were established when an abundance of iron ore was discovered in the ponds and marshes that surround the town. One such enterprise was the Washington Iron Works, established in 1822 by Colonel Bartlett Murdock and George Howland in what is now West Wareham. "*This was a large rolling mill and nail factory containing thirty-five machines. A year later they erected a second dam and built a forge for making bar iron out of scrap iron by a rolling process.*"[3] In 1845, Washington Iron Works was purchased by the Tremont Iron Company, whose foundry was located in Wareham center. The company enlarged their works by constructing a second stone dam at Tremont and building "*a large storehouse for nails ... east of the branch track of the Cape Cod Branch Railroad Company, at Tremont,* [as well as] *a number of tenements.*"[4] Thus, a

[2] See "N.Y.N.H. & H.R.R. Boston to Provincetown Bridge No. 45.38, Wareham Road, Repairs, December, 1945," Massachusetts Highway Department, Bridge Section files.

[3] Frederika A. Burrows, "Nail-Making in Wareham," Cannonballs and Cranberries (Taunton, MA, 1976), p. 38.

[4] Noble Warren Everett, "History of Wareham," in History of Plymouth County Massachusetts, Duane Hamilton Hurd, compiler (Philadelphia, 1884), p. 213.

small village was established and became known as Tremont. In 1858 the Tremont Iron Company sold its entire assets to the Tremont Nail Company which gained a national reputation for manufacturing cut nails. The West Wareham plant was out of service by the late 1920s, but the main plant in Wareham Village continues to this day and is reputed to be the country's oldest nail manufacturer.

Railroad History

In 1846, the Cape Cod Branch Railroad received a charter to construct a railroad line from Middleboro to Sandwich on Cape Cod. This line was completed in 1848 and ran through West Wareham and Wareham Village. The following year, the Fairhaven Branch Railroad was chartered to construct a line southward from the Cape Cod Branch Railroad at West Wareham to the town of Fairhaven. This line was completed in 1854.[5] Tremont Station was located just east of the junction of these two lines, appearing on historic maps as early as 1879, although it was possibly built much earlier. In 1872, the two railroad lines became part of the Old Colony Railroad system, a network which at its peak in 1900 encompassed over 600 miles of track in eastern Massachusetts. The Old Colony Railroad was leased by the New York, New Haven & Hartford Railroad (N.Y.N.H.&H.R.R.) in 1893. After World War I, passenger service declined and all service was terminated on the Old Colony lines in 1959. Conrail presently uses the tracks as a spur line through West Wareham for local freight deliveries on an intermittent basis.

Construction of Tremont Station Bridge

Early in 1887 J.T. Pierce of Rochester (the town adjoining Wareham to the west) petitioned the Plymouth County Commissioners for a grade separation at the point where Carver Road crossed the Old Colony Railroad tracks at Tremont Station, and for the alteration of highways over land of the Tremont Nail Company. A hearing was held at Tremont Station on May 4, 1887 as indicated in the annual town report of 1888 which states:

> *The railroad company desired that the Carver road should be discontinued at the existing crossing, and that far north of the crossing a highway bridge should be erected twenty feet above the tracks, and new roads be constructed on each side of the railroad to connect this bridge with the existing highways.*[6]

Local citizens expressed concern about "*circuitous travel and much new road making,*" while the Tremont Nail Company was concerned for its lands and tenements, "*especially because communication with the mill, and between its two villages would be daily impeded by elevated and winding roads.*" The town selectmen were largely interested in financial matters, as "*the total expenditure was to be considerable–estimated by some computations to aggregate*

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[5] Louis P. Hager and A.D. Handy, History of the Old Colony Railroad from 1844 to the Present Time (Boston, 1893), p. 399.

[6] Town of Wareham, Selectmen's Annual Report on the Finances of the Town of Wareham for the Year Ending Feb. 1, 1888 (Middleboro, MA, 1888), p.7.

$15,000–and likely to fall largely upon Wareham."[7] Further meetings were held with town and county officials to hear the concerns of all parties. Finally, on November 15, 1887:

> *The County Commissioners located the railroad bridge about 500 feet northerly from the Carver crossing, laying out at each end a rising embankment about 200 feet in length for approaches. They also laid out a new highway easterly from the railroad from the Carver road to the old Middleboro road, connecting with the easterly end of the embankment, or approach, of the bridge. They also laid out a highway from the westerly embankment, or approach, near the Union Chapel, leading southerly through the woodland to the Pierceville road. And they discontinued the Carver road at the level railroad crossing, and also discontinued the old Middleboro road from the Union Chapel northerly to the house owned by Savary Morse, including another level railroad crossing.*[8]

Special Commissioners appointed by the Superior Court decreed that the bridge, its abutments and embankments were to be built and maintained by the railroad; the roads and highways were to be built and maintained by the town; and the county was to pay all the land damages.[9] After advertising for bids, the town selectmen chose local contractor Charles McDermott to build the required roads and approaches. Town reports indicate that McDermott was paid $720 for this work and that the bridge and abutments were completed in the fall of 1888.

Whether or not the railroad recycled a bridge from another location is unclear. However, records of the New York, New Haven & Hartford Railroad, the subsequent owners of the structure, indicate that this bridge was originally built in 1878 and was rebuilt at its present location just nine years later, in 1887.[10] Old Colony Railroad reports from the late nineteenth century indicate that beginning in the 1880s the railroad made every effort to eliminate as many grade crossings as possible on its lines. A company report from 1887 stated:

> *The work of abolishing grade-crossings has been continued. Two grade-crossings at Tremont have been avoided by the construction of a new highway in Wareham, partly paid for by this company, and arrangements have been made by which two other highways in Wareham, now crossing at grade, shall be brought together and carried over the railroad by a bridge. ... It is the purpose of the directors wherever a grade crossing of any kind can be abolished, at a reasonable expenditure, to use every effort to remove it.*[11]

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7 Ibid., pp. 7-8.

8 Ibid., p. 8.

9 Ibid., p. 9.

10 New York, New Haven & Hartford Railroad Bridge List, Massachusetts Highway Department, Bridge Section files.

11 Old Colony Railroad, Twenty-fourth Annual Report of the Directors of the Old Colony Railroad Company to the Stockholders, November 22, 1887 (Boston, 1887), p. 6.

Structural evidence, including missing and/or non-matching rivets at all upper chord splice plates, suggests that the trusses may have been disassembled and moved at an early date. In addition, the heavy proportions of the truss members suggest that the bridge was originally designed to carry railroad loadings, not the much lighter highway loadings of the period. It has been theorized that the bridge was built in 1878 as a railroad bridge at some other location and the trusses were moved and re-erected at their present location in Wareham in 1887. The conversion of the bridge from a railroad span to a highway span was possibly prompted by the collapse of the Bussey Bridge in Dedham on March 14, 1887. This catastrophe caused many railroad companies to reconsider the adequacy of their metal truss roadway bridges, and to begin replacing those whose adequacy was at all questionable.[12]

Thomas Pratt and the Pratt Truss

The Tremont Station Bridge is a Pratt truss, a common type of short-span bridge at the turn-of-the-century. Historian Carl Condit has called Thomas Pratt (1812-1875): "*the creator of...the first scientifically designed truss,* [and]*...the most thoroughly educated American bridge builder at the beginning of the railroad age.*"[13] Born in 1812 to Boston architect Caleb Pratt, Thomas Pratt was educated early in the field of building construction. He studied architecture at Rensselaer Polytechnic Institute, and went on to work for the United States Army Corps of Engineers. In 1833 he began his career designing bridges for railroads and was employed as a structural engineer by a number of New England railroad companies.

In 1844 Thomas Pratt and his father Caleb jointly patented the Pratt truss which featured diagonal members in tension and vertical members in compression, thus reversing the truss system patented by William Howe in 1840. "*The design was superior to Howe's mainly in the more functional distribution of tensile and compressive stresses in the various members.*"[14] The Pratt truss was not particularly popular in the early years for timber bridge construction, but by 1870, the standard Pratt truss "*was becoming a common feature on the Pennsylvania Railroad and its numerous affiliates.*"[15] By the turn of the century, the Pratt truss became one of the most common bridge truss types for shorter spans, as noted by J.A.L. Waddell in 1916:

> *The Pratt truss ... is the type most commonly used in America for spans under two hundred and fifty (250) feet in length. Its advantages are simplicity, economy of metal, and suitability for connecting to the floor and lateral systems.*[16]

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[12] Stephen J. Roper, Massachusetts Highway Department Historic Bridge Specialist, "Massachusetts Historic Bridge Inventory: Bridge W-06-08, Pierceville Road Bridge, 1989."

[13] Carl W. Condit, "Pratt and Whipple Trusses," American Building Art, the Nineteenth Century (New York, 1960), p. 109.

[14] Ibid., p. 111.

[15] Ibid.

[16] J.A.L. Waddell, Bridge Engineering, vol. I (New York, 1916), p. 468.

Jacob H. Linville, Andrew Carnegie and Keystone Bridge Company

The Tremont Station Bridge is one of the earliest known examples in Massachusetts of an iron truss incorporating the "weldless," or upset-ended, eyebar patented by Jacob H. Linville (1825-1906) and John L. Piper (dates unknown). Linville was a civil engineer who had been employed as chief bridge engineer for the Pennsylvania Railroad and pioneered the use of wide, upset-ended eyebars for tension members. Piper was chief mechanic for the Pennsylvania Railroad shops at Altoona, Pennsylvania. Both men had professional dealings with industrialist Andrew Carnegie (1835-1919), who served as Superintendent of the Western Division of the Pennsylvania Railroad Company from 1853 until 1865. In 1862 Jacob H. Linville and John L. Piper received U.S. Patent No. 34,183 for an "*Improvement in Iron Truss-Bridges,*" which in part consisted of the use of a series of wide, thin eyebars connected by pins for the lower chord. Three years later, in 1865, the two men received a second patent, No. 50,723 which made certain improvements upon their first patent, including the use of wide, thin eyebars with enlarged ends, formed by upsetting the iron by compression "*for the purpose of increasing the density, toughness, and strength of the eye of the rod, and enlarging the eye without diminishing its transverse section.*"[17] The specifications for the lower chord of the bridge truss described within the patent read as follows:

> *The lower chords ... consist of wide, thin rolled iron bars, with enlarged ends, which are made by upsetting the rolled bars by compressing them into the desired shape in molds, into which the heated iron is forced under immense pressure, thereby increasing the density, toughness, and strength of the enlarged ends, and permitting the holes or eyes for the connecting pins ... to be cut out without rendering the transverse section at the eye less than that of the other parts of the bar or diminishing the transverse or longitudinal strength of the chord-bar.*[18]

In 1862, Linville and Piper, along with Andrew Carnegie and Aaron Shiffler (a bridge supervisor for the Pennsylvania Railroad) were organizing Piper & Shiffler, the predecessor of the Keystone Bridge Company, in Pittsburgh, Pennsylvania. In his autobiography, Carnēgie wrote of the company's formation:

> *When at Altoona I had seen in the Pennsylvania Railroad Company's works the first small bridge built of iron. It proved a success. I saw that it would never do to depend further upon wooden bridges for permanent railway structures. An important bridge on the Pennsylvania Railroad had recently burned and the traffic had been obstructed for eight days. Iron was the thing. I proposed to H.J.* [sic] *Linville, who had designed the iron bridge, and to John L. Piper and his partner, Mr. Schiffler* [sic], *who had charge of bridges on the Pennsylvania line, that they should come to Pittsburgh and I would organize a company to build iron bridges. It was the first company of its kind. I asked my friend Mr.* [Thomas] *Scott,* [Vice-President] *of the Pennsylvania Railroad, to go with us in the venture, which he did. Each of us paid for a one fifth interest,*

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[17] Jacob H. Linville and John L. Piper, "U.S. Patent No. 50,723," p. 3.

[18] Ibid.

> *or $1250. My share I borrowed from the bank. Looking back at it now the sum seemed very small, but "tall oaks from little acorns grow."*
>
> *In this way was organized in 1862 the firm of Piper and Schiffler* [sic] *which was merged into the Keystone Bridge Company in 1863--a name which I remember I was proud of having thought of as being most appropriate for a bridge-building concern in the State of Pennsylvania, the Keystone State. From this beginning iron bridges came generally into use in America, indeed, in the world at large so far as I know.*
>
> *... In Linville, Piper, and Schiffler* [sic], *we had the best talent of the day--Linville an engineer, Piper a hustling, active mechanic, and Schiffler* [sic] *sure and steady.*[19]

In 1862, anticipating the growing demand for iron railway bridges, Carnegie began to reorganize Piper & Shiffler as the Keystone Bridge Company, a move that was completed by 1865.[20] Linville served as President and Chief Engineer, Piper served as General Manager, and Shiffler was Assistant General Manager of the new company. Keystone Bridge Company initiated the use of wrought iron for all principal truss members and advertised as its specialties: "*Linville & Piper Patent Wrought Iron Bridges for Railways, Highways, Parks, Cities & c. Improved Wrought Iron Turn-Tables, Iron Roofs, Patent Tubular Columns and Weldless Eye Bars.*"[21] These weldless eyebars were also referred to in advertisements as "*Upset Chord Links*," and were said to be available in any length up to 50 feet and any head width up to 20 inches.[22]

The company soon obtained many large contracts for railroad bridges, including a 300-foot span over the Ohio River at Steubenville and the Eads Bridge at St. Louis. By 1874, the company had enlarged its works to include: "*machine shops, smith-shops, riveting-sheds, bolt-cutting and testing houses, pattern-shops, a large iron building for a foundry, offices, stables, and all the accessories of a first-class establishment.*"[23] A promotional booklet from 1874 enumerated 275 iron truss spans, 110 iron girder spans, and 343 wooden spans, totaling 112,500 feet in length, which Keystone Bridge Company had constructed for railroads.[24]

In 1867, the demand for all shapes and sizes of iron for bridges led to the erection of a large iron foundry adjacent to the Keystone Bridge shops. Carnegie wrote of this enterprise:

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19 Andrew Carnegie, Autobiography of Andrew Carnegie (Boston / New York, 1920), pp. 115-17.

20 Joseph Frazier Wall, Andrew Carnegie (New York, 1970), p. 229.

21 Illustration in Victor C. Darnell, A Directory of American Bridge-Building Companies 1840-1900, Society for Industrial Archeology, Occasional Publication No. 4 (Washington, DC, 1984), p. 68.

22 Keystone Bridge Company, Illustrated Album, 1874, p. 45.

23 Ibid., p. 7.

24 Ibid., pp. 34-42.

> *The Keystone Works have always been my pet as being the parent of all the other works. But they had not been long in existence before the advantage of wrought- over cast-iron became manifest. Accordingly, to insure uniform quality, and also to make certain shapes which were not then to be obtained, we determined to embark in the manufacture of iron.*[25]

Originally known as Carnegie, Kloman & Co., the firm was later known as the Union Iron Mills. By 1874, the iron works contained: "*thirty-seven puddling furnaces, fourteen heating furnaces, seven trains of three-high rolls, and one 'Universal Plate Mill,'* " the latter of which was designed and patented by Andrew Kloman for rolling heavy flat bars up to 36 inches in width.[26] The immense capacity and success of this company is evidenced by a statement made by J.A. L. Waddell in the introduction to his 1884 work <u>The Designing of Ordinary Iron Highway Bridges</u>: "*The sections of iron employed* [throughout this book] *are those rolled at the Union Iron Mills, for the reason that* ... [there is] *more iron rolled in these mills than anywhere else in America.*"[27] Carnegie continued to invest his profits in his companies and stated in his autobiography that by the mid-1880s Union Iron Mills had become, "*the leading mills in the United States for all sorts of structural shapes.*"[28] A Union Iron Mills founder's mark is visible on the upper chord of the west truss of the Tremont Station Bridge.

The Keystone Bridge Company's contribution to the field of engineering technology was undeniably their extensive use of wrought iron for all principal truss members in bridges. The company was also successful in incorporating many of Linville and Piper's design innovations into their bridges, particularly the use of upset-ended eyebars for lower chords, a feature which would become standard in late-nineteenth century pin-connected trusses. From its inception, the company was an important and prolific late-nineteenth century bridge manufacturer, of which it was said: "*In the completeness, extent and adaptation of all the tools and appointments required for heavy bridge construction, these works are unrivalled in this country.*"[29] In later years, Carnegie himself wrote of the Keystone Bridge Company's success:

> *The Keystone Bridge Works have always been a source of satisfaction to me. Almost every concern that had undertaken to erect iron bridges in America had failed. Many of the structures themselves had fallen and some of the worst railway disasters in America had been caused in that way. Some of the bridges had given way under wind pressure but nothing has ever happened to a Keystone bridge, and some of them have stood where the wind was not tempered. There has been no luck about it. We used only the best material and enough of it, making our own iron and later our own steel. We were our own severest inspectors, and would build a safe structure or none at all. When asked to build a bridge which we knew to be of insufficient strength or of*

25 Ibid., p. 130.

26 Edwards, p. 242.

27 Ibid.

28 Carnegie, p. 176.

29 <u>Manufactories and Manufacturers of Pennsylvania of the Nineteenth Century</u> (Philadelphia, 1875), p. 367.

> *unscientific design, we resolutely declined. Any piece of work bearing the stamp of the Keystone Bridge Works (and there are few States in the Union where such are not to be found) we were prepared to underwrite.*[30]

Between 1891 and 1894, the Keystone Bridge Company became a subsidiary of Carnegie Steel Company and changed its name to Keystone Bridge Works. In 1900 the Keystone Bridge Works was absorbed by J.P. Morgan's American Bridge Company, along with 24 other firms representing *"fifty percent of the nation's fabricating capacity."*[31] One year later, American Bridge Company became a subsidiary of United States Steel. At the present time, there are only two other known Keystone-built bridges in Massachusetts: a single-span plate girder highway bridge in Montague and one span of a former three-span Whipple through truss railroad bridge between Montague and Deerfield, both of which were built in 1880 for the Turners Falls Branch of the New Haven & Northampton Railroad. Keystone-built bridges were not particularly common in Massachusetts, where many local firms competed for business.

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30 Carnegie, p. 122.

31 Darnell, pp. 85-86.

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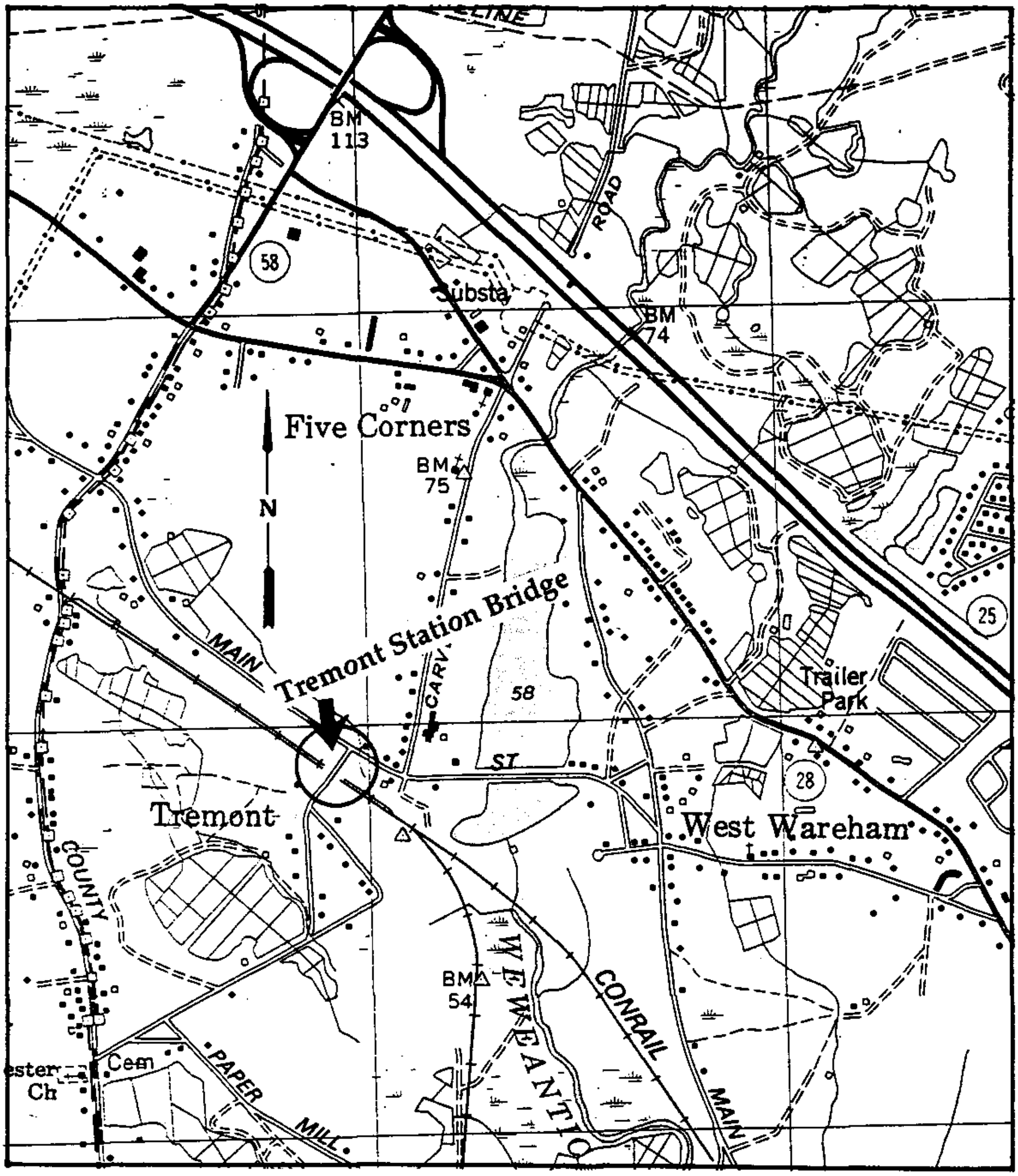
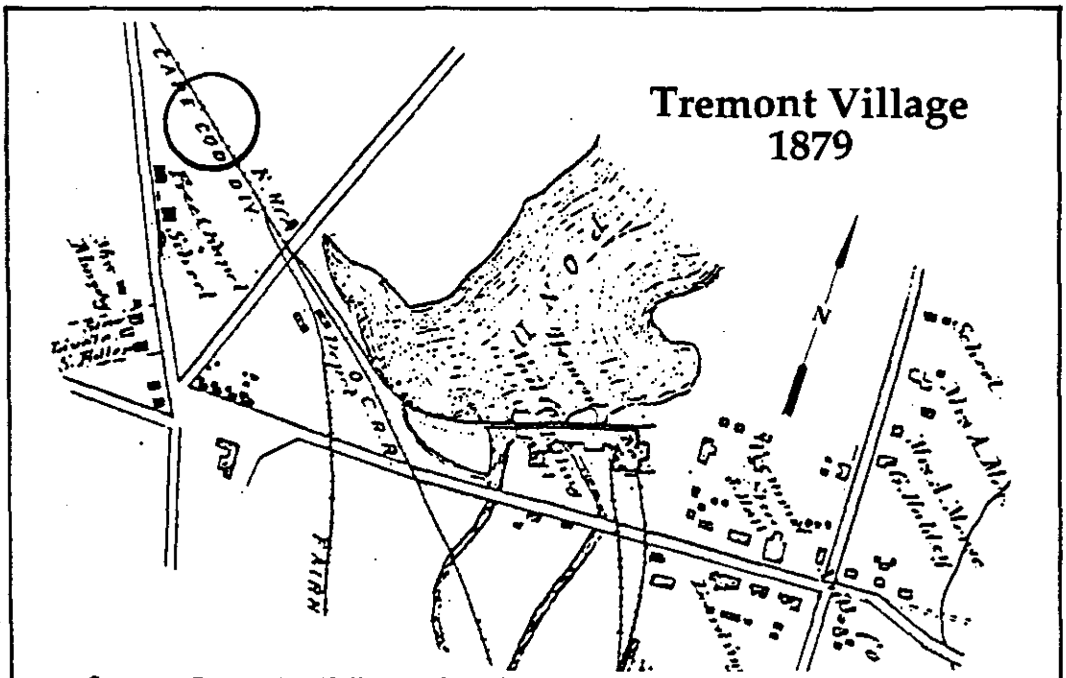
D. Likely Sources Not Yet Investigated

All likely sources of information have been investigated.

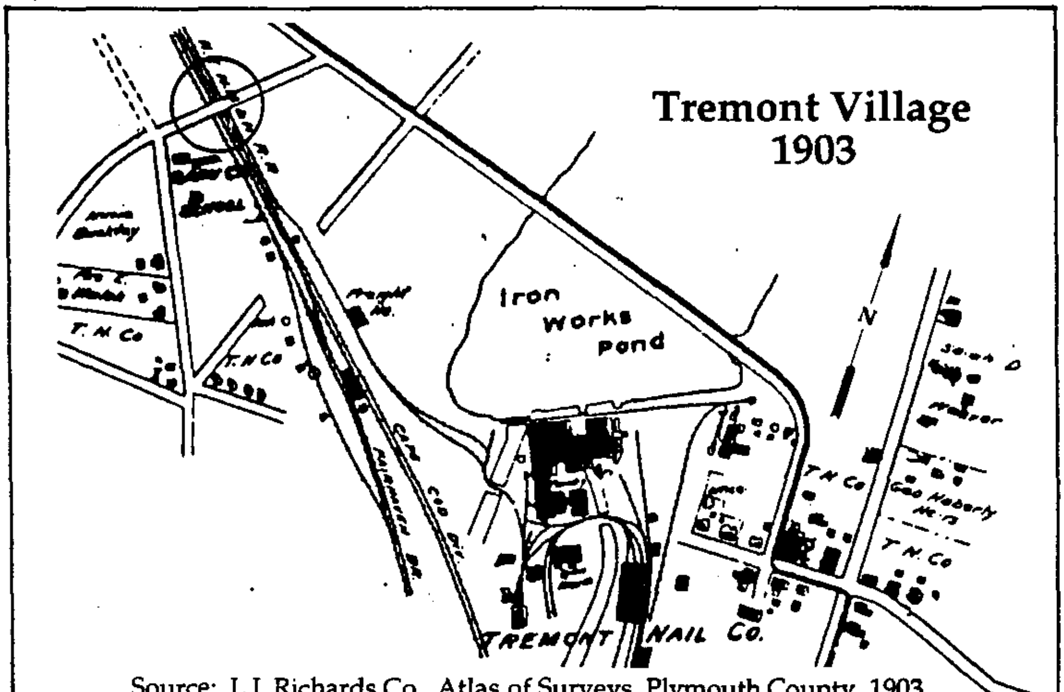


Location Map, showing site of Tremont Station Bridge.
Source: U.S.G.S. Snipatuit Pond, Mass. Quad., 1977.

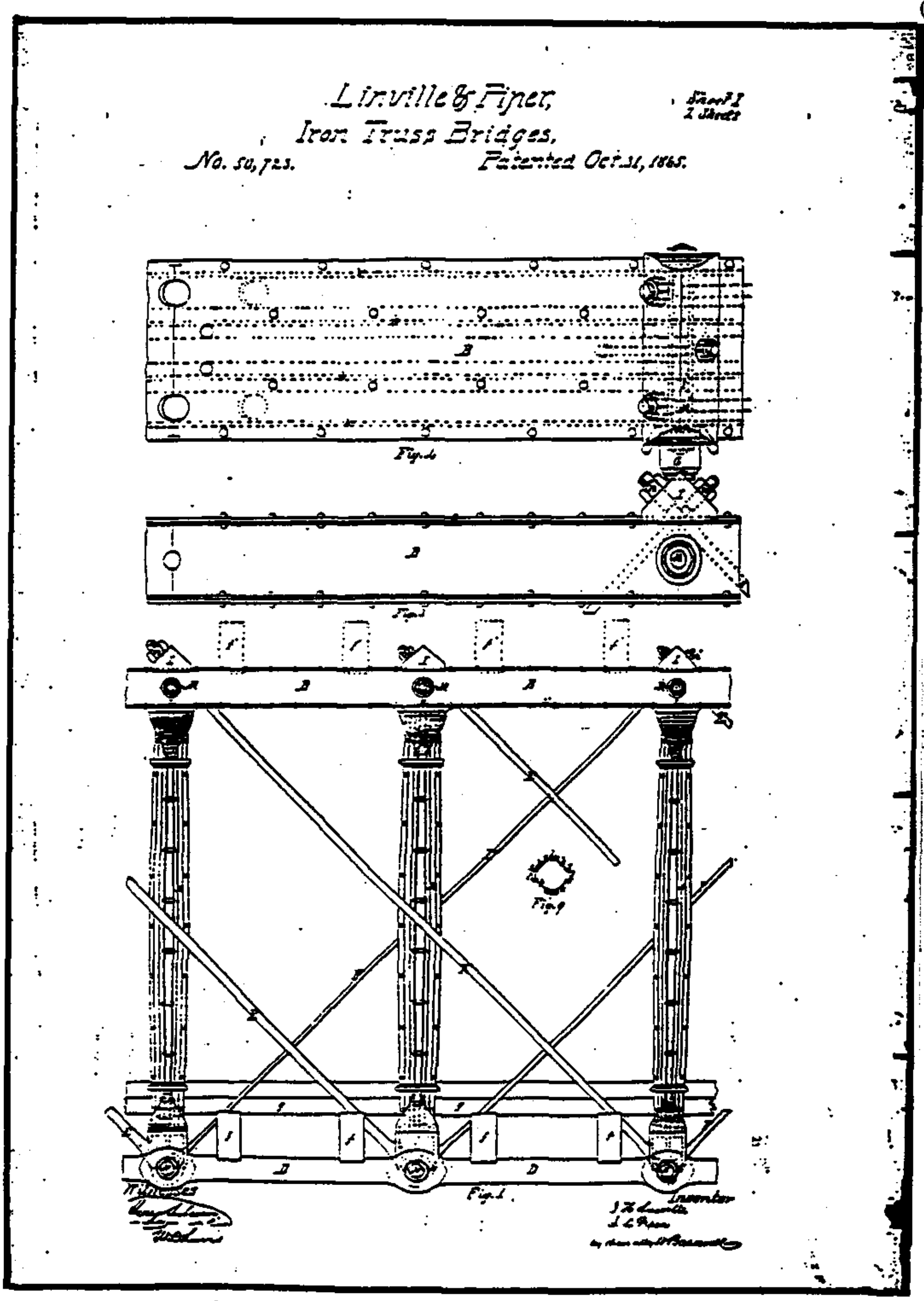


Source: George H. Walker, Atlas of Plymouth County Massachusetts, 1879.

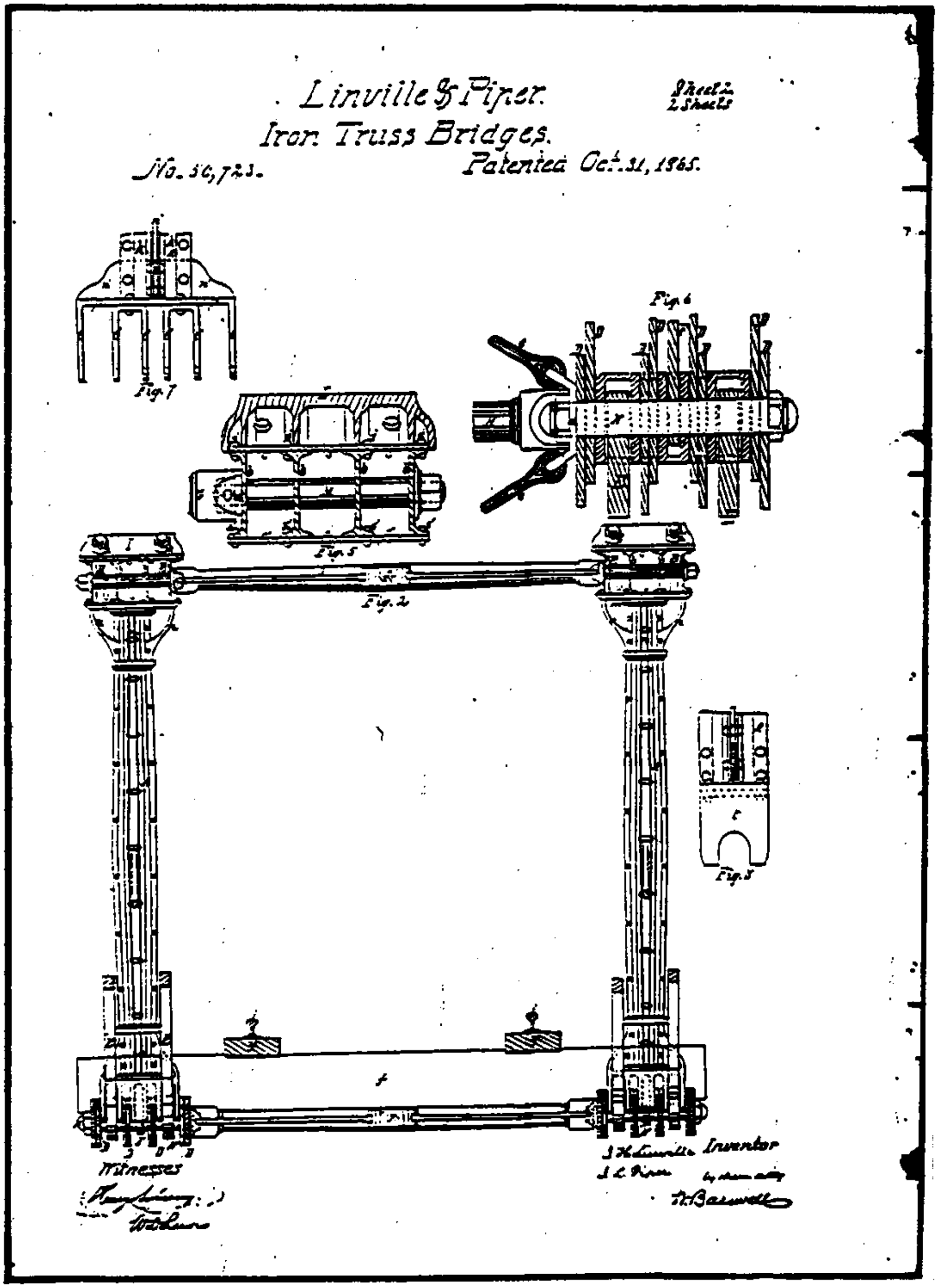
Historic maps showing roadway changes at site of Tremont Station Bridge.



Source: L.J. Richards Co., Atlas of Surveys, Plymouth County, 1903.



Patent Drawing, Sheet 1,
"U.S. Patent No. 50,723, October 31, 1865," J.H. Linville and J.L. Piper
[U.S. Patent Office Records, microfilm copies at Boston Public Library.]



Patent Drawing, Sheet 2,
"U.S. Patent No. 50,723, October 31, 1865," J.H. Linville and J.L. Piper
[U.S. Patent Office Records, microfilm copies at Boston Public Library.]

UNITED STATES PATENT OFFICE.

JACOB H. LINVILLE, OF PITTSBURG, AND JOHN L. PIPER, OF ALTOONA, PENNSYLVANIA.

IMPROVEMENT IN WROUGHT-IRON BRIDGES.

Specification forming part of Letters Patent No. 50,723, dated October 31, 1865.

To all whom it may concern:

Be it known that we, JACOB H. LINVILLE, of Pittsburg, in the county of Allegheny and State of Pennsylvania, and JOHN L. PIPER, of Altoona, in the county of Blair and State of Pennsylvania, have invented a new and useful Improvement in Wrought-Iron Bridges or Other Truss-Frames; and we do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a side elevation of two panels of a wrought-iron truss-bridge with double intersecting diagonal tension-bars. Fig. 2 is a transverse section of the same. Fig. 3 is a side elevation of the wrought-iron upper chord. Fig. 4 is a top view of the same. Fig. 5 is a transverse section of the upper chord through the center of the angle-block in the plane of the center of the post. Fig. 6 is a horizontal section through the base of the post and lower chord-bars. Fig. 7 is an end view of the wrought-iron base of the post. Fig. 8 is a side view of the base of the post. Fig. 9 a cross-section through the center of a post.

The same letters are used in the several figures to indicate similar parts of the bridge.

Our invention consists of certain improvements in the construction of the wrought-iron truss-bridge for which Letters Patent of the United States were granted to us on the 14th January, 1862.

In the truss-bridge shown in the accompanying drawings, the general arrangement of the parts is similar to that shown in our previous patent just referred to, the improvements forming the subject-matter of this invention relating to the following particulars: First, the posts, instead of being made of two rolled plates of iron of semi-polygonal transverse section united by rivets passed through the center of the polygon and sprung apart by distance-plates, are made of two or more plates of wrought-iron with flanges at the edge, the plates being so united as to make hollow posts by rivets passed through the flanges, and each plate being arched longitudinally by means of ferrules placed at intervals between the flanges and around the rivets, and instead of casting the bases and capitals onto the ends of the posts we use bases and capitals connected by rivets to the post; second, instead of making the upper chords of hollow cast-iron sections or short tubes, we construct our upper chords of a combination of wrought-iron I-shaped beams or channel-bars, or both, connected by wrought-iron plates, so as to form cellular chords of great strength and capacity of resisting either transverse strain or longitudinal compression; third, the use of bottom chords of thin wrought-iron plates, the eye of which, at each end, instead of being cut out of a rolled plate and drilled or forged into shape, is upset under strong compression, so as to give at the eye of the bar a degree of strength equal or superior to that of the bar at any point between the eyes.

To enable others skilled in the art to construct and use our improvements, we will proceed to describe them more particularly.

In our bridge the upright posts A A are placed at regular intervals in each span, and opposite to each other on each side, so that the transverse struts G may be placed across and at right angles to the roadway, between the upper chords immediately above the capitals of the opposite posts, and transverse struts H similarly placed between the bases of the opposite posts, the ends of the struts G and H being attached to the connecting-pins M and N, which pass through the upper chords immediately above the capitals and through the bases of the posts respectively, as shown in Fig. 2.

To a plate, *d*, on the inner end of the connecting-pin M, is attached the end of a diagonal brace, *e*, of which there are four in each panel of the bridge on a level with the upper chords meeting in a ring, *r*, in the center, to which they are screwed, and four similar braces, *e*, are attached to the connecting-pins N at the bottom of the posts A in each panel, and meet in a ring, *r*, in the center, to which they are screwed in the same manner. The bases of the posts A are connected at their bases longitudinally by the lower chords, D, of which four may be placed parallel to each other on each side of each panel. They are made of thin bars of rolled iron of sufficient depth and placed on edge, so as to support the roadway, and are attached to the bases of the posts by the connecting-pins N, which pass through the hole or eye near the end of these bars.

Patent Text, Page 1,
"U.S. Patent No. 50,723, October 31, 1865," J.H. Linville and J.L. Piper
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The top chords, B, composed of wrought-iron beams and plates, riveted together, as hereinafter described, are made in sections or lengths reaching from center to center of the posts A lengthwise of the bridge, and are placed on the capitals of the posts and are held in position by projections or pins on the capital of the post which enter holes c in the lower surface or plate, c', of the chords.

On top of the upper chords, B, and just over each post A, and covering the joint or meeting-point of the ends of the chords, is an angle-block, I, which may be made hollow and of cast-iron, as seen in section in Fig. 5. These angle-blocks form the upper bearing of the nuts n^2, at the ends of the tension-braces E and the counter tension-braces F, which support the bridge. Each tension-brace E starts from the angle-block I at top of one post, passes through the upper chord and downward diagonally, passing outside of the next post, crossing it at midway from its top and bottom, and thence extends to the bottom of the third post, where a loop or eye at the end of the brace E receives the connecting-pin N, two such braces E being used side by side, one passing on each side of the posts A. The counter-tension braces F (which run diagonally in the opposite direction to the braces E) start from the angle-block I at top of each post A, pass through the upper chord, B, and thence through the center of the next or second post, and thence to the bottom of the third post, where the connecting-pin N passes through the eye or loop at the lower extremity of the counter-brace F.

The roadway is composed of sills f, placed transversely on top of the lower chord-bars, D, and the string-pieces g, which sustain the rails i, are placed longitudinally on the sills, as shown in Fig. 1; or, if a deck-bridge is required, the sills f are placed on top of the upper chords, B, as shown by dotted lines in Fig. 1.

Having thus described the general construction and arrangement of our bridge, we will proceed to explain more minutely the peculiar features of the posts, upper chords, and lower chords.

The posts consist of three principal parts, the shaft, the base, and the capital. The shaft is made of pieces of rolled iron k, of sufficient length to extend from the top of the capital to the base. In the drawings these posts are represented as made of four such pieces of iron; but the number is not material, as two would suffice if they are bent or curved so as to form a hollow post. The edges of these pieces k are turned outward, so as to form a flange on each edge. Instead of uniting these pieces or plates k by bringing the flanges together, they are separated by ferrules l or small tubes of sufficient diameter to receive the rivets s. These ferrules are placed between the opposite flanges of the plates k, and then a rivet, s, passed through the flanges and ferrule and fastened in the usual manner, by upsetting, unites them firmly. The length of the ferrules l determines the distance between the opposite faces of the flanges, this distance being greatest at the center of the post and gradually diminishing toward each end, thus making the post A thickest in the middle.

The capital and base may be made of wrought or cast iron, but we prefer the former, as less liable to fracture. The capital consists of a cap-plate, m, placed on top and riveted to the post, and supported by brackets n, of wrought-iron, placed between the flanges of the plates k composing the post, in place of the ferrules, and also riveted to the flanges of the plate k. The bases are made in the same manner, a base-plate, p, (see Fig. 7,) being united to the plates k of the post by brackets n', passing between the flanges of the plates and riveted thereto. The ends of the base-plate p (which may also be made of wrought-iron) are turned down, forming ribs t (see Fig. 7) and intermediate or mid ribs, t' t', are added between the ribs t t by riveting to the under side of the base-plate. These ribs t and mid-ribs, t', have semicircular notches cut in them, as seen in Fig. 3, so as to straddle the connecting-pin N, and they serve to separate and keep in place the diagonal tension-braces E, the counter-braces F, and the eye-bars or lower chords, D, as seen in Figs. 1 and 6.

The cap-plate m of the post may be turned up at the edges, so as to keep in place the top chords; or this may be effected by pins in the cap-plate entering the holes x in the under side of the lower plate, c', of the upper chords.

It is obvious that the shape of the cross-section of the posts may be varied from that shown in Fig. 9 by adding to or reducing the number of plates k, so as to make a circular or polygonal post of any number of sides.

The top chords are made by uniting by rivets s' any convenient number of I-shaped beams, b, of rolled iron, to an upper plate, c, and lower plate, c', both also of rolled iron. The outside beams may be channel-bars instead of I beams, as in Fig. 5; or either channel-bars or I-beams may be used, if desired. These top chords are made in lengths equal to the distance between the post A from center to center, and are framed together at the shop before being built into the bridge. The semicircular holes at the abutting ends of these upper chords formed in the ends of the channel-bars and I-beams admit of the passage of the connecting-pin M, to which the lateral eye-plate d and lateral diagonal braces e' are attached. (See Fig. 2.) The rolled I-beams and channel-bars afford transverse strength to sustain the floor-timbers f f (when a deck-bridge is to be built) without the use of auxiliary beams, and they also prevent the vertical strain caused by the diagonal tension-braces E from crushing the chords over the posts; and by reason of their peculiar cellular construction the sectional area of these combined chords can be graduated in each panel of the bridge in proportion to the compressive strain to be resisted. The width of the top

Patent Text, Page 2,
"U.S. Patent No. 50,723, October 31, 1865," J.H. Linville and J.L. Piper
[U.S. Patent Office Records, microfilm copies at Boston Public Library.]

and bottom plates, combined as described, affords great lateral stiffness and the cellular form is most effective in resisting forces of compression.

The lower chords, D, consist of wide, thin rolled iron bars, with enlarged ends, which are made by upsetting the rolled bars by compressing them into the desired shape in molds, into which the heated iron is forced under immense pressure, thereby increasing the density, toughness, and strength of the enlarged ends, and permitting the holes or eyes for the connecting-pins N to be cut out without rendering the transverse section at the eye less than that of other parts of the bar or diminishing the transverse or longitudinal strength of the chord-bar.

We do not claim the upsetting of iron bars in the manner described nor any peculiar mode of performing the operation, but merely the use of chord-bars for bridges, the ties of which are thus formed so as to give additional strength to the bar where it is so much needed.

Having thus described our improvements in wrought-iron truss-bridges, which are applicable also to truss-frames for other purposes, what we claim as our invention, and desire to secure by Letters Patent, is—

1. The use of posts for wrought-iron truss-frames having a curved or polygonal sections composed of two or more plates of rolled or wrought iron with flanged edges, secured together by means of rivets passing through such flanges and through ferrules interposed between them to give any desired enlargement to the posts and leave space for the passage of counter-braces without cutting away or weakening the post, such posts being completed by bases and capitals of wrought or cast iron riveted thereto, substantially as and for the purposes hereinbefore described.

2. The use of upper chords or compression-beams, formed by a combination of I-shaped rolled beams or channel-bars, or both, riveted at top and bottom to plates of wrought-iron, so as to form in each chord or beam a series of rectangular tubes or cells, for the purpose of affording great transverse strength to support the weight of passing trains in railroad or other bridges, combined with great resistance to compressive force, substantially as hereinbefore described.

3. The use for the lower chords of truss-frames of wide and thin rolled bars with enlarged ends, formed by upsetting the iron, when heated, by compression into molds of the required shape for the purpose of increasing the density, toughness, and strength of the eye of the rod, and enlarging the eye without diminishing its transverse section, substantially as hereinbefore described.

In testimony whereof we, the said JACOB H. LINVILLE and JOHN L. PIPER, have hereunto set our hands.

JACOB H. LINVILLE.
JOHN L. PIPER.

In presence of—
A. S. NICHOLSON,
W. D. LEWIS.

Patent Text, Page 3,
"U.S. Patent No. 50,723, October 31, 1865," J.H. Linville and J.L. Piper
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